[redacted] 25X1

Copy No. 2 of 7 copies
21 May 1962

MEMORANDUM FOR: Chief, Technical Plans & Development Staff

SUBJECT: The Design and Fabrication of an Optical-Mechanical Rectifier, as proposed by [redacted] 25X1

1. A meeting was held several weeks ago with representatives from GIMRADA, AMS and NPIC to discuss rectification problems associated with the KH-4 and 201 program reconnaissance systems. The Technical Plans and Development Staff, as a result of this meeting, solicited a proposal from [redacted] for the design and fabrication of optical-mechanical rectifiers. [redacted] 25X1 discussed this proposal with [redacted] GIMRADA, [redacted] AMS, and 25X1 representatives of the Technical Plans and Development Staff. Approximately two weeks ago, Messrs. [redacted] discussed the problem further at [redacted] A revision of the proposal was received at NPIC shortly after this meeting and a second meeting was held at NPIC to discuss the proposal. On 15 May, [redacted] 25X1 visited [redacted] at Rome Air Development Center to discuss the common problem of rectification and the possibility of joint procurement. After this meeting, Messrs. [redacted] further discussed the proposal with Mr. [redacted] and, as a result of this conversation, a second revision of the proposal was received at NPIC on 18 May 1962.

2. There are several reasons why NPIC has been working with the GIMRADA and AMS representatives in helping them obtain a satisfactory proposal from [redacted]

a. NPIC knew the personnel and clearance status at both [redacted] and GIMRADA-AMS, and offered to help in setting up the initial meeting. 25X1

b. NPIC probably does not have a sufficient demand levied upon it to require a production capability in producing rectified prints. It will probably continue to have a limited requirement and support of the installation of equipment at AMS would allow NPIC to obtain required rectifications on request.

c. Pursuant to the general support of equipment development for the Intelligence Community need outlined in NSCID #8, such support of development programs is required in the NPIC mission.

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3. A staff study was prepared, with Technical Plans & Development Staff guidance, by [redacted] and [redacted] after they had conducted discussions with [redacted]. This staff study is Enclosure #1 to this memorandum. 25X1

4. It is recommended that the Technical Development Committee approve the recommendations stated in the enclosed staff study and that the Army fund [redacted] toward this development work, and the remaining portion of the development of one prototype rectifier would be funded by NPIC. The NPIC portion of this development cost would be [redacted] which includes [redacted] for the fabrication of one prototype and [redacted] for the design study. It has been agreed that NPIC will provide Rome Air Development Center with a copy of the design study. 25X1 25X1

5. Technical monitoring of the contract would be conducted jointly by NPIC and the Army.

[redacted] 25X1

Acting Chief, T&S

Enclosures (3)

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NPIC/TP&DS: [redacted]

ENCLOSURE #1 to [redacted] 25X1

STAFF STUDY

1. PROBLEM:

A requirement exists for the development and procurement of a photographic rectifier for the rectification of tilted panoramic photography from photo reconnaissance systems.

2. FACTS BEARING ON THE PROBLEM:

a. Need for Rectification. Panoramic photography has inherent geometric characteristics which preclude using it directly without rectification for most purposes. To either make true scalar measurements from this photography or to use it to prepare mosaics at a uniform scale, it must be rectified.

b. Types of Panoramic Photography to be Rectified. There are presently two different operational photo reconnaissance systems for which rectification equipment has not been developed or manufactured. These two systems are the KH-4 and the 201 systems. These systems are similar in that they both employ convergent panoramic cameras and therefore would require very similar type rectification to restore the true geometry of the photo exposure. However, the two camera systems employ different focal length lenses, film widths, tilt angles, etc., so that one single rectification unit could not satisfy both restitution problems.

c. Applicability of Present Equipment:

(1) Since the materials obtained through the KH-4 system are relatively identical, with one exception, to those obtained through the KH-1, KH-2, and KH-3, the AMS (NSPA) has modified the [redacted] 25X1 Rectifier Model 9005, which was developed for the KH-1, to accommodate the KH-4 material. This modification consisted of adding a capability for removing tilt which is present in the KH-4 materials but not the KH-1, KH-2, and KH-3.

(2) Rectification instruments of this type have not been developed or manufactured to handle the materials from the 201 system.

(3) Existing rectifiers are not capable of being modified to accommodate the materials from the 201 system.

d. Coordination of Development and Procurement. The two primary users of this type of rectifier are organizations within the Air Force and the Army. Each of these organizations has solicited, and received proposals, for the design and development of two different model rectifiers, one to handle the KH-4 materials, the other to handle the materials for the 201 system. The characteristics desired in the instruments by the

Army and Air Force at the time of the solicitation were similar but differed in certain details. Representatives of the two services have therefore met to consolidate their requirements so that an instrument could be developed to handle the KH-4 materials for both the Army and Air Force and similarly for the 201 materials. This is now being carried out on the working level and will result in non-duplication of design effort in the event that both services obtain rectifiers.

e. Availability of Manufacturers. Security restrictions prevent most manufacturers of precision optical and photogrammetric equipment from being considered in this proposed procurement. Two contractors in this field which meet the security requirements are [redacted] and [redacted] is the only one with experience in designing and constructing rectifiers of the type desired. Therefore, solicitation of proposals solely from [redacted] was considered advisable.

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f. Availability of Funds. Fiscal Year 62 funds in the amount of [redacted] are available for transfer from AMS to NPIC to support the design and procurement of one rectification instrument.

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3. DISCUSSION:

a. Although the AMS and ACIC are the primary user of this type equipment, there are requirements within NPIC, Navy PIC, HO, etc., for the products of these proposed rectifiers. It is proposed that should one of these rectifiers be procured it would be installed at AMS for use in the joint CIA-AMS program which generates the greatest work load for this type of equipment. AMS would service the requirements of NPIC and the other organizations in the Washington area for rectified panoramic photography and would thus permit most efficient utilization of the instrument.

b. Since AMS has, through the modification of their present equipment, been able to satisfy the immediate requirements for the rectification of the KH-4 materials, there remains only an urgent requirement for the rectification capability for the 201 materials.

c. Due to the short time remaining in this fiscal year and because of the present Air Force procurement procedures, it is not possible to enter into a joint procurement contract. However, the following arrangements were agreed upon by Army and Air Force representatives as being suitable to prevent duplication of development effort and cost which might otherwise result from separate contracts.

(1) NPIC with the financial support of AMS and technical support of GIMRADA would contract for the design study as described in the [redacted] proposal and for an instrument as developed in the design study. A duplicate of this design study would be provided the Air Force.

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(2) The Air Force would contract for the number of instruments required by ACIC and SAC but would omit the design study from the contract. The Air Force contract would be effective only after completion of the design study and coordination of requirements with NPIC.

(3) Air Force contract would include the requirements for spare parts listing, test criteria, manuals, and final report. These items would be provided to NPIC-Corps of Engineers by the Air Force.

(4) Monitoring of the two contracts would be closely coordinated to assure maximum benefit and minimum cost to the Government.

d. The attached technical proposal and budgetary cost estimate from [redacted] are the results of repeated negotiations by both representatives of the Army and the Air Force. 25X1

4. CONCLUSIONS:

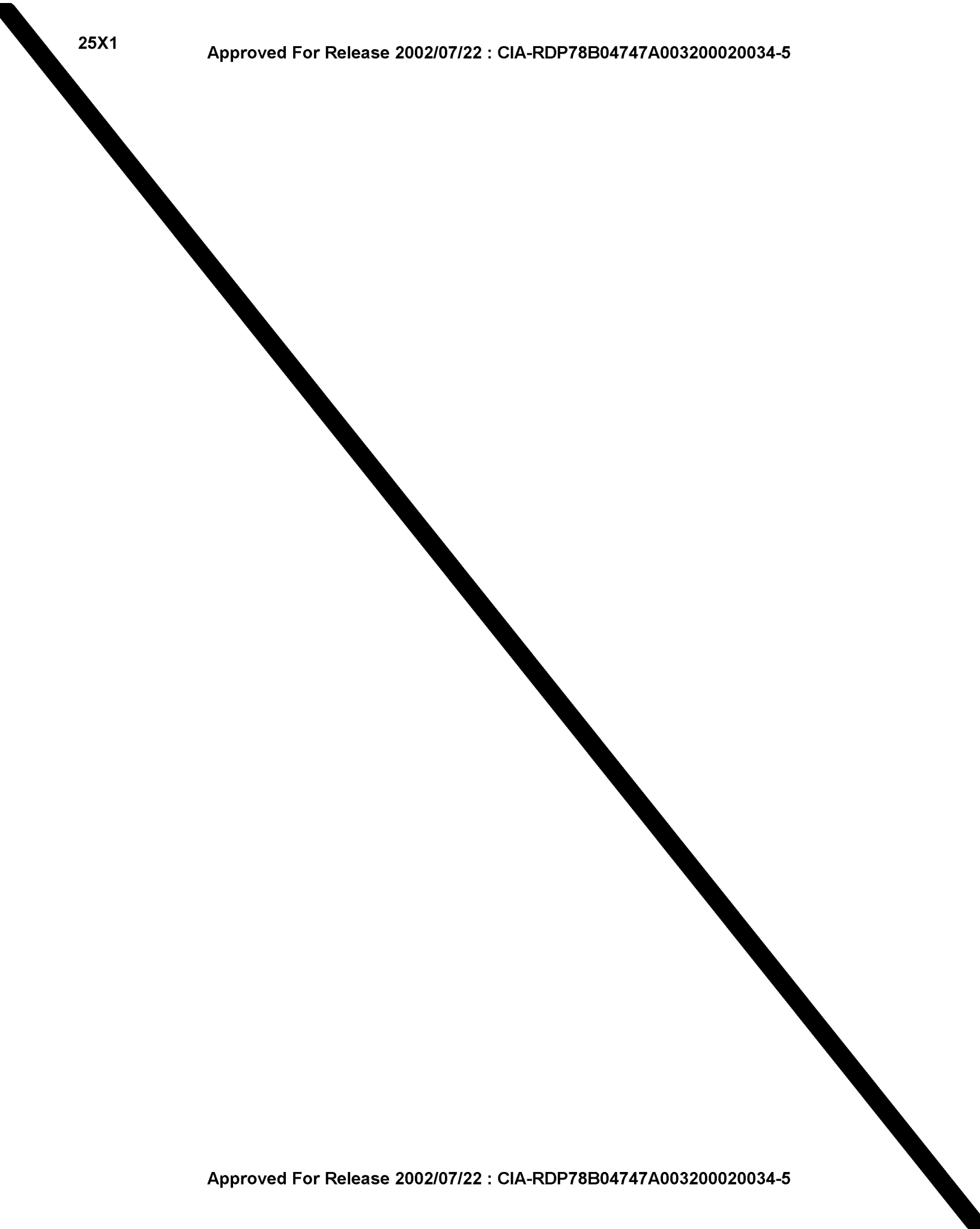
a. Requirements of the NPIC and AMS justify the design and procurement of a rectification instrument for the photographic materials from the 201 reconnaissance system.

b. A joint contract with the Air Force for this procurement is not possible under the circumstances.

5. RECOMMENDATIONS:

a. NPIC proceed with the contract negotiations for the design and procurement of the equipment as outlined in the attached [redacted] proposal. 25X1

b. During the course of the contract, maintain close liaison with the Air Force, if the Air Force also contracts with [redacted] to eliminate duplication of design effort and hold down costs. 25X1



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2. Time-Temperature Versus Resolution. The maximum resolution achieved was 89 lines/mm and remained the same throughout all six time-temperature combinations ranging from 68°F to 118°F. An interesting correlation was observed; as the temperature increased, and the time decreased, the exposure required to maintain the 89 lines/mm level was increased progressively across the 21 step tablet. (The preparation of the master resolution target was described in the Interim Report under assignment [redacted]

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3. Time-Temperature Versus Chemical Fog. Contrary to the anticipated results, the fog level remained constant showing that this particular emulsion lends itself very well to high-temperature processing.

4. Time-Temperature Versus Relative Speed. The following formula was used to calculate relative speed.

Speed = S_A relative sensitivity = $\frac{1}{E}$, where density = 0.6 above gross fog.

The variation observed, from the control film sample to the highest processing temperature and the shortest processing time sample, showed a decrease in Relative Speed which equals 1/4 of a camera stop.

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5. Time-Temperature Versus Granularity . The [redacted] Quality Meter power supply unit is presently under calibration. The granularity test will be conducted as soon as the meter is again available. A study will be made to determine if there is a significant increase in granularity as the processing temperatures are increased and the corresponding processing times reduced.

In accordance with the information previously mentioned in this report, (namely, films that are commonly used by SAC and TAC) the next film to be investigated will be film type 5427. In the seventh monthly progress report, it was indicated that film type 4401 would be tested in this reporting period, but, due to non-availability of such film, this was not possible.

In this test, as well as the tests previously reported, the maximum solution temperature reached has been 118°F, and the time 15 seconds. Due to the procedure and equipment used, it was determined that developing and stopping of the films at temperatures beyond 118° F with the processing time correspondingly shorter than approximately 15 seconds was impractical if the high level of processing control was to be maintained.

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Much effort has apparently been devoted to the subject of time and temperature, but less to the problem of agitation. Consistency and reproducibility are of prime importance in the experimental processing of photographic materials and it is therefore essential to obtain an optimum level of agitation.

It is the opinion of this research group that a tool missing in the sensitometric research field, is a laboratory-type processor capable of duplicating the various methods of agitation currently used in the processing industry. These are, spray, nitrogen burst, immersion, turbulation bars and liquid bearings, the latter being restricted in use. Photographic processing data published by leading film manufacturers, do not generally state the method of agitation employed during the photographic experiments conducted to determine the sensitometric characteristics of an emulsion, and its relationship, or response, to a given developing formula.

The performance of an emulsion as notified by a manufacturer is, under these terms, very difficult to reproduce under a specific condition. With the restrictions placed on a test program of this type due to the foregoing, it is proposed during the next reporting period to study the requirements of a laboratory-type processor capable of employing the various types of agitation previously noted, and operating over a broad band of processing times, ranging from twenty (20) minutes to 1/2 second, or less. The machine will require an accurate temperature control system.

25X 2. Assignment [redacted] Tests to obtain the coefficient of friction of film at increasing velocities have been completed and the results plotted. Sample equations of various lengths of film at various speeds are being worked on to assess the accuracy of the results against data observed from the HTA/5 and EH49 processors.

To obtain the results, a complete rebuild of the test rig was necessary, the float was dispensed with since wind and water movement prevented the taking of accurate readings. A test stand in which the reel and drive were mounted on a pendulum suspension was substituted for the float, and a catamaran hull used to support the film. A standard two-foot test length of film was attached to the catamaran which was pulled through the water to measure the towing equipment drag at the various selected velocities. The test length was then replaced with a 52-foot length, and the towing equipment drag for each velocity deducted.

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25X1 3. Assignment [redacted] The plastic dome was fitted to the [redacted] liquid 25X1
bearing, and the bearing remounted in the test tank. Field tests to plot the pressure distribution over various speeds of revolution are continuing.

25X1 4. Assignment [redacted] Design studies into the development of a self-powered air bearing incorporating a transverse flow fan have proved to be very disappointing. Three different designs of these fans are, or will be available, of which only one type was reasonably suitable for incorporating
25X1 into an air bearing. This was the [redacted] type. Prototype testing of this
fan at the research laboratories of the [redacted] has 25X1
revealed that the concept has a basic fault in that if a sudden back pressure in the air outlet occurs, a flow reversal in the two vortex generators is started. This reversal, which results in a reversal of air flow through the fan, with the consequent problems involved, once started continues until the fan is shut off or another transient back pressure is applied.

Further design studies will now be conducted to employ a combination of conventional centrifugal and impeller fans. A quantity of these have been
25X1 obtained on loan from the [redacted] for this purpose.

ADDENDUM TO MONTHLY REPORT

This report summarizes an investigation, extra-curricula to current assignments, held to study if an improved method of accelerating density gain in film under development, by the use of microwave frequencies, could be employed.
25X1 In 1962, [redacted] conducted experiments to evaluate an experimental technique known as heat shock, and determined that the technique was effective in minimizing the image-quality degradation resulting from high temperature processing. This technique applies the heat in very short impulses and provides rapid cooling of the emulsion to normal operating temperature, to obtain the necessary density gain without undesirable grain growth.

The method finally selected for the controllable development processor under study was a stainless steel band stretched across a roller, half submerged in developer solution. The film travelled emulsion side up under the band. With the addition of a suitable detergent to decrease the surface tension, the film carried an even layer of developer on its surface to the band, under which it formed a continually replenished meniscus during transport of the film. Power was applied to the band which became in effect a strip heater, and transferred the heat to the meniscus, which increased the developing rate without seriously swelling the gelatin emulsion. Since one of the objectives of the processor development

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program is to increase the efficiency of processors, it was felt that some attention should be paid to the benefits that might occur if a processor was designed with this system incorporated as a part of the development process.

In the processor built, considerable difficulty was encountered in solving the problem of "banding." These were dark bands running across the width of the film, and were traced to an uneven transport speed, variance of the meniscus depth, lack of absolute concentricity in the rubber covered applicator rollers, and radial play in the roller bearings. All these conditions could cause dwelling of the film under the applicator band, or changes to the depth of the meniscus which affected the heat transfer rate from the band. The results on the film from either source were the same, in that bands of darker density were produced.

It was considered that if microwave frequencies could be used to provide sufficient energy to heat film as it passed between the transducer plates, that due to the nature of this method, the close mechanical tolerances and micro adjustments of the applicator bands could be avoided.

Study of this method showed that a uniform distribution of power over the full width of the film is not possible, and it appears that no practical technique is available. The film within the energy field would consist of the film base, and the gelatin emulsion containing the silver halide. Such a material does not excite evenly. The molecular activity induced in the areas of heavy silver deposits, acts as short circuits which induce arcing and uneven heating. The areas of heavy silver deposits are those retained in the exposed areas of the film image and give the film a non-uniform dielectric constant. These short circuits would cause permanent damage to the emulsion, thereby rendering this method unsatisfactory. Radio frequencies in the range of 1000 mc to 10,000 mc were considered. No power sources were found to be available in higher frequencies.

During the above study it was suggested that a satisfactory method of producing energy to heat film might be obtained from dielectric heating, in the 400 mcs range, in which heating would occur as a result of a current flow between two capacitor plates. However, it is the firm opinion of all specialists consulted, that the non-uniform dielectric constant of the film, due to the presence of varying deposits of silver halide in the emulsion would result in uneven development.

The companies cooperating in this study were the [redacted] 25X1

25X1 [redacted]

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A close check on the budget expended to this date indicates that providing no heavy expenditure of funds on equipment is required, the present level of effort of four full-time staff members will be maintained to complete work on the various projects assigned.

Funds committed or expended to date are approximately [redacted] 25X1

Enclosed for general information are five (5) copies of a chart depicting film drag coefficient results obtained from Assignment [redacted] detailed on page 4 of this report. Also enclosed is one set of three pictures illustrating some of the test apparatus used in various tests. 25X1

If you have any questions, or if we may be of further assistance to you, please feel free to contact us.

Very truly yours,

25X1 [redacted]

Research Manager Contract Administrator

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ASSIGNMENT [redacted]

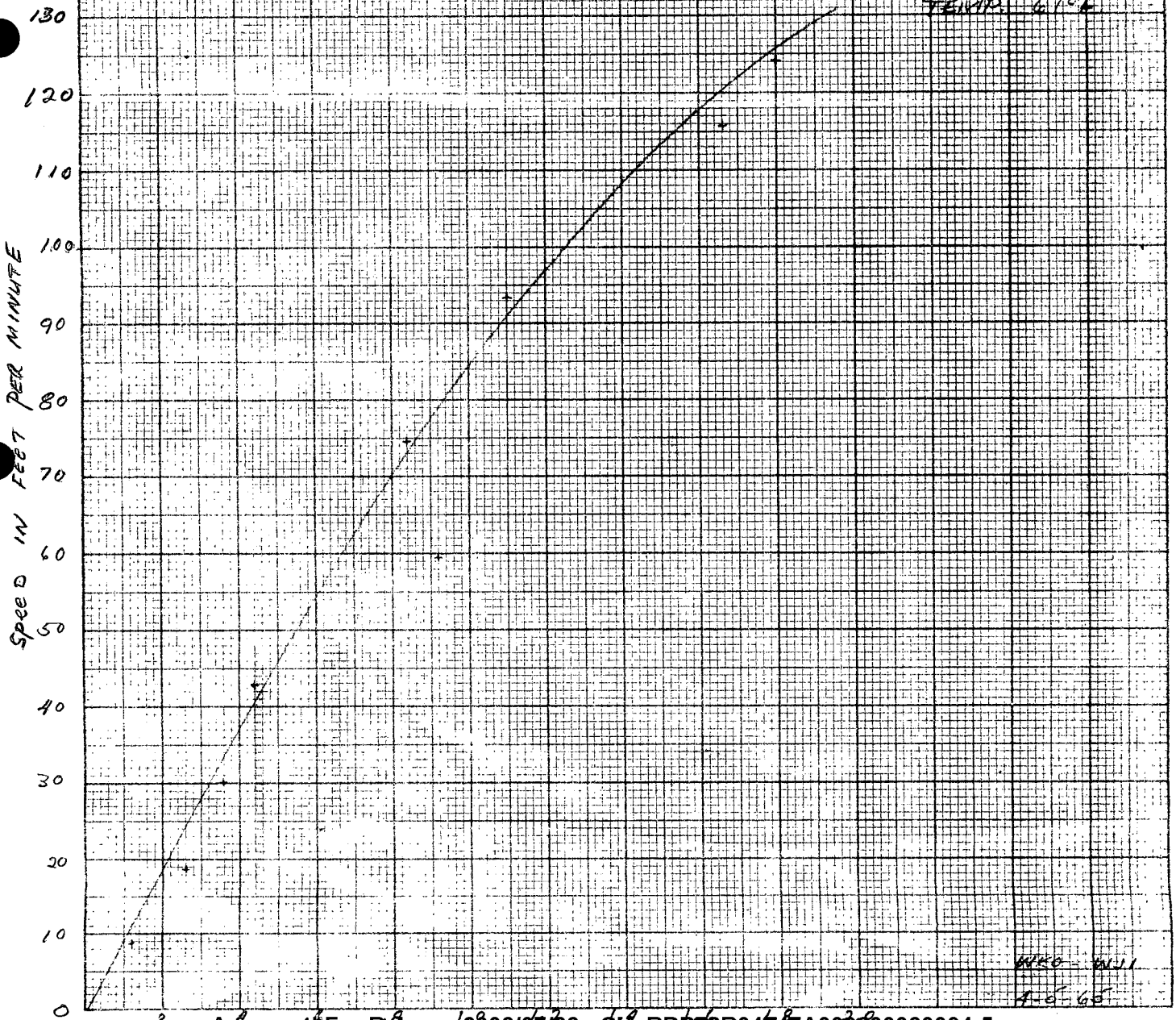
FILM DRAG COEFFICIENTS

9½-INCH × 8.25 MIL SPOOL

ACETATE BASE

BLACK AERO LEADER

TEMP. 61°F



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ASSIGNMENT [redacted] 25X1

FILM DRAG COEFFICIENTS

9½-INCH × 8.20 MIL SPOOL
ACETATE BASE
BLACK AERO LEADER

TEMP. 61°F

SPEED IN FEET PER MINUTE

130
120
110
100
90
80
70
60
50
40
30
20
10
0

.2 .4 .6 .8 1.0 1.2 1.4 1.6 1.8 2.0

DRAG

AREO - WASH
4-8-60

10 X 10 TO THE ½ INCH 359-11G
KEUFFEL & ESSER CO.